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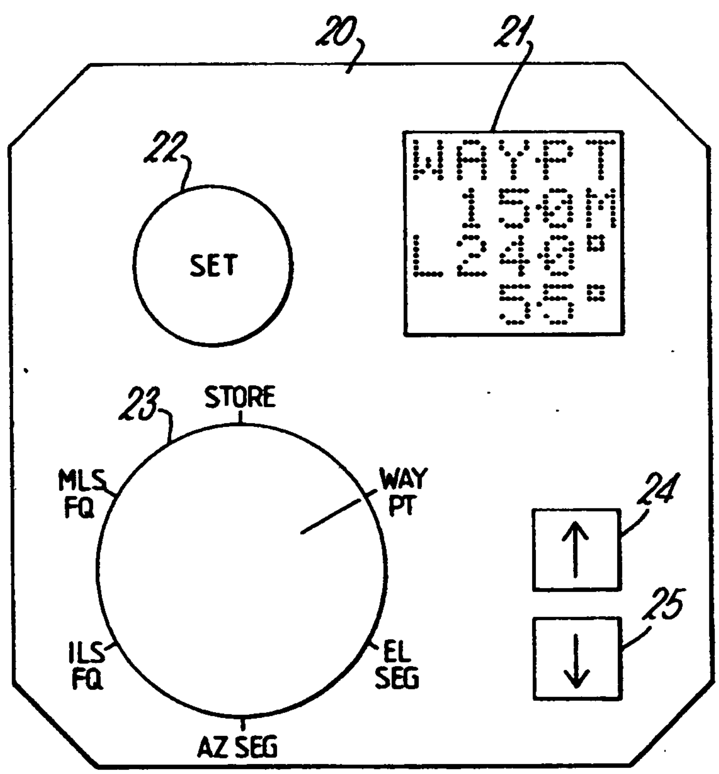
(54) Aircraft MLS instrument display

(57) An aircraft instrument (3) for use with an MLS receiver 1 has a front panel 20, (30, 40, 50) with a display 21, (31, 32, 42, 46, 48, 51) dedicated to information concerning the aircraft landing approach path, which includes an indication of the aircraft's present position. A switch 23 on the front panel can be set to way point, elevation segment or azimuth segment and a rotatable knob 22 is turned to set the value. When setting the azimuth segment the knob 22 is rotated in one direction to display an azimuth deviation one side of the MLS centre line and in the other direction to display azimuth deviation on the other side of the MLS centre line. A scroll button 24, is used to display information up or down the display. The instrument may include inputs from the ILS receiver (8) (Fig. 1) and distance measuring equipment (2) and may provide output to an autopilot (4) and flight instrumentation system (5). The display may have an array of electrically-energisable elements or a cathode-ray tube display, and may provide a map display of the area scanned by the MLS beam together with a representation of the aircraft landing approach path.

Fig.2.



GB 2 174 663 A

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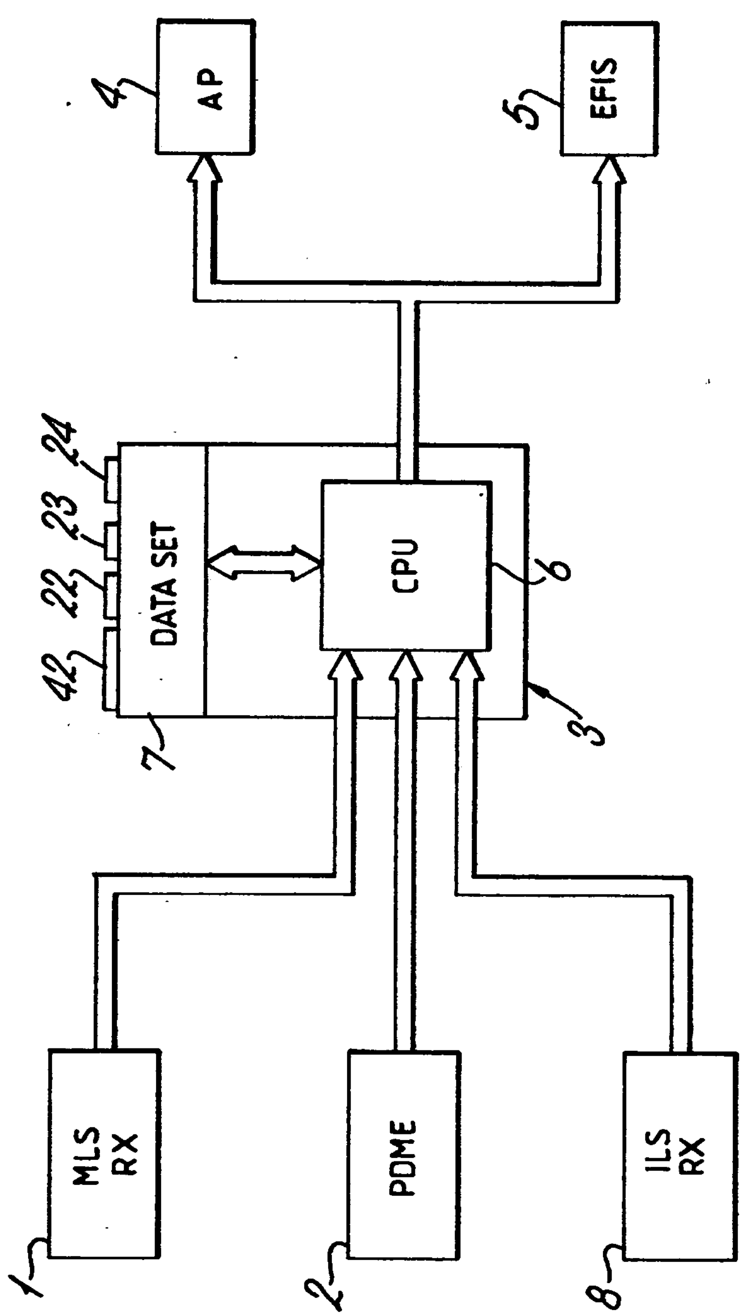
1/5

Fig.1.



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2/5

Fig.2.

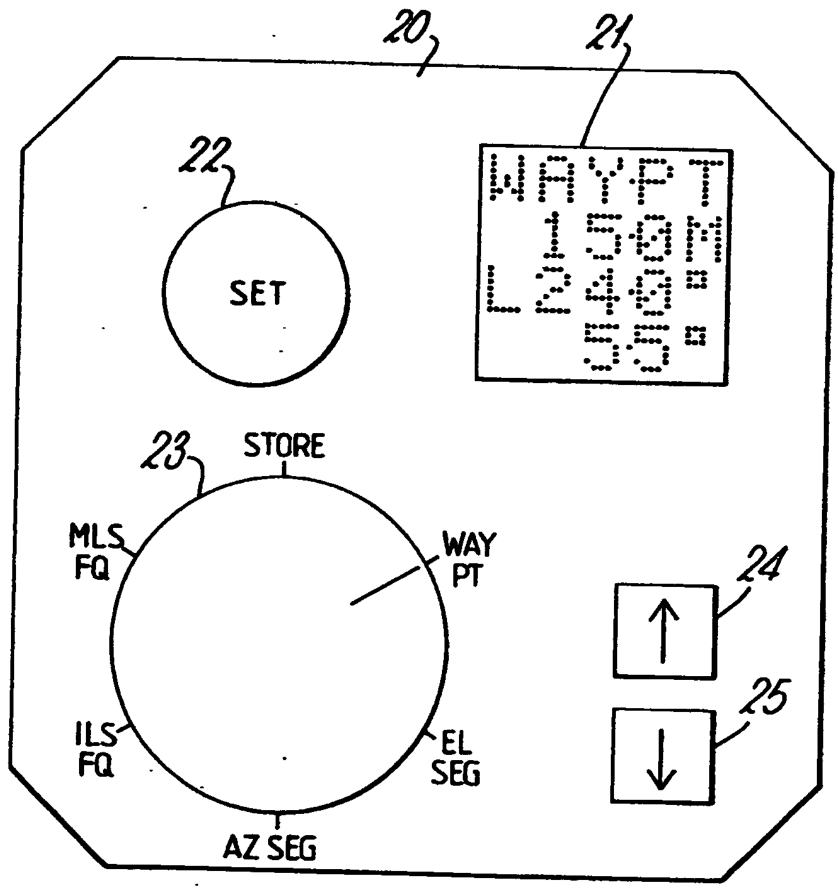
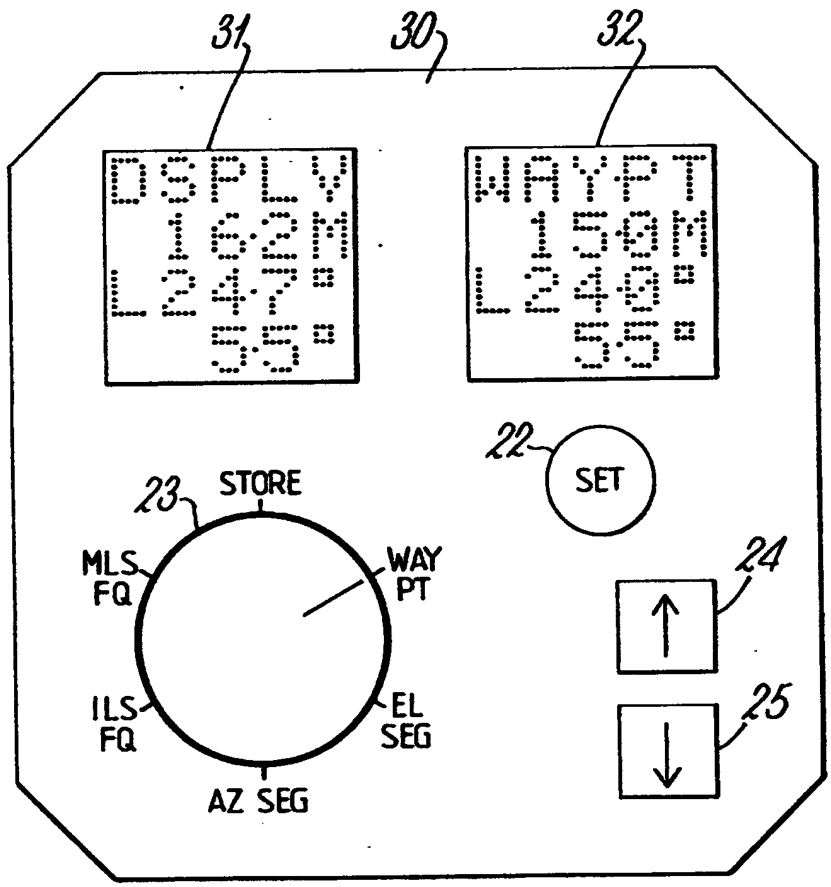
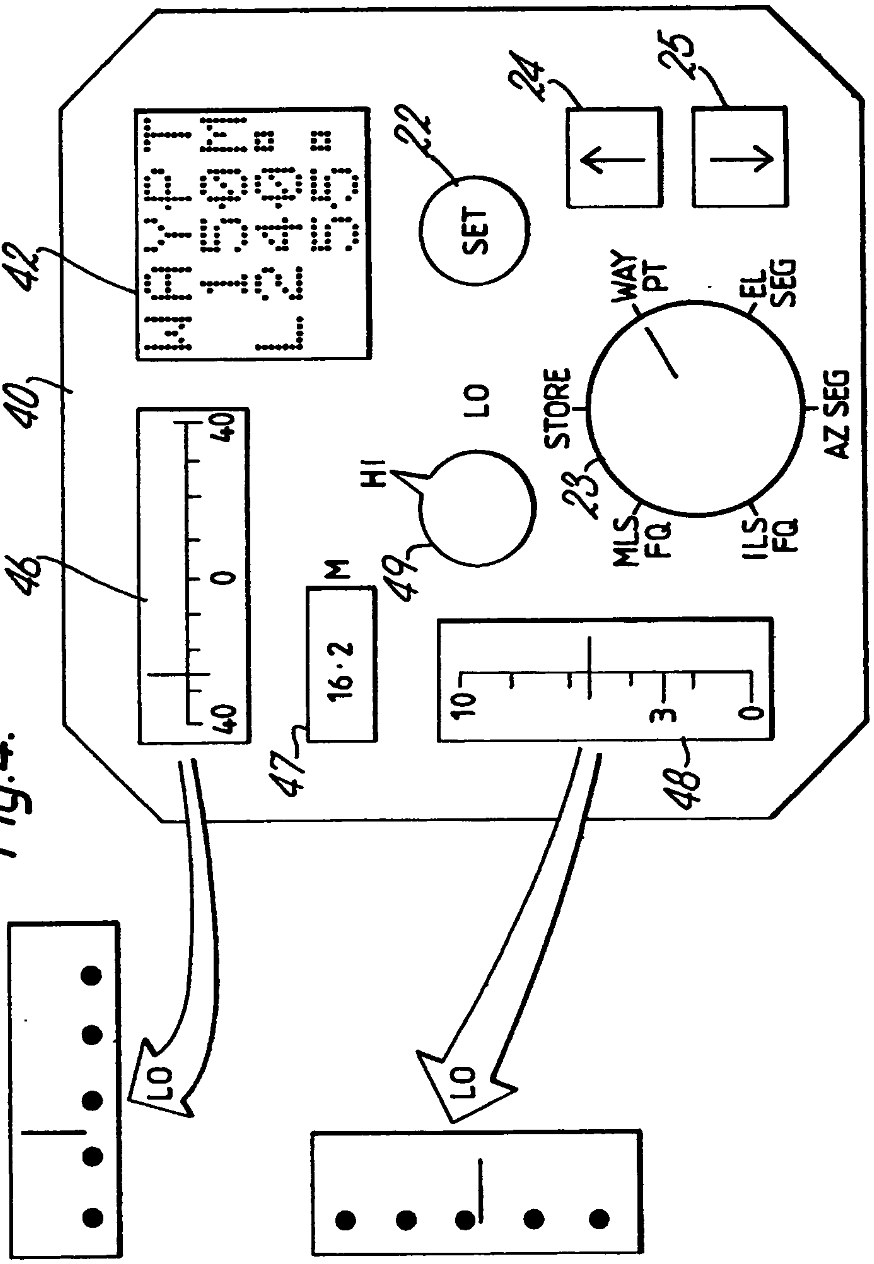


Fig.3.


31
30
32
DSPLY
16.2M
L24.7°
5.5°
WAYPT
15.0M
L24.0°
5.5°
22
SET
23
STORE
WAY
PT
MLS
FQ
ILS
FQ
EL
SEG
AZ SEG
24
25



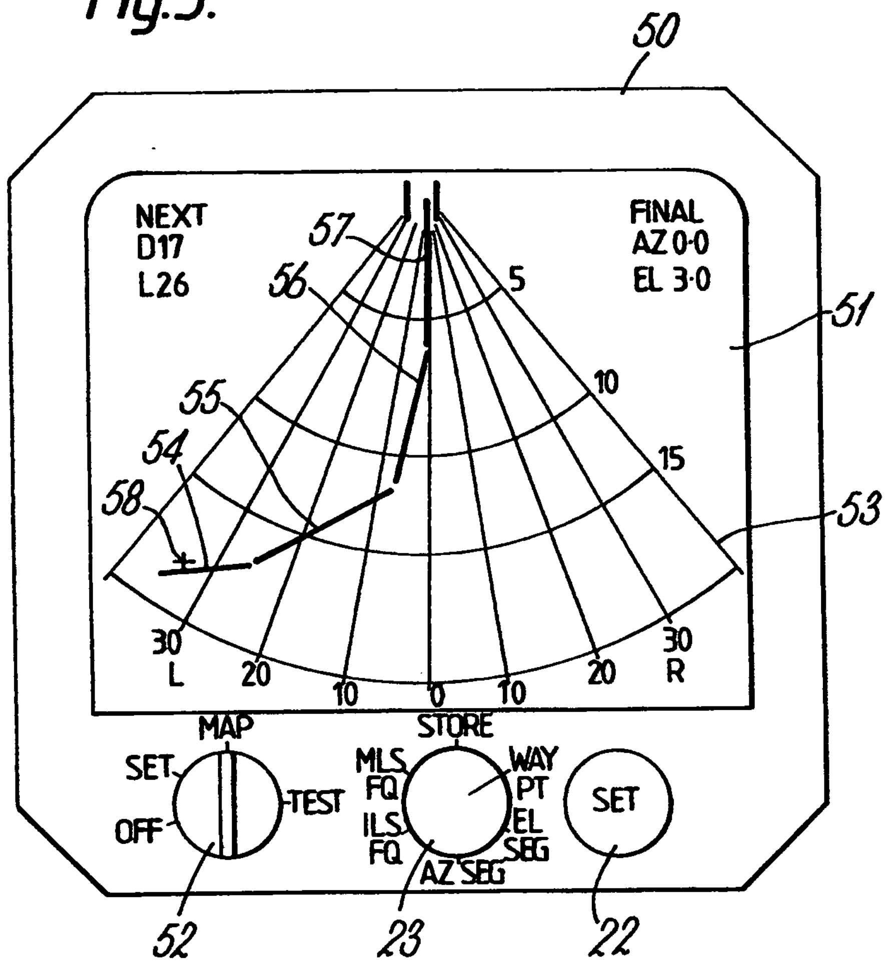
WAY PT 1
TE 0.05
L 2 5.45
SET
LO
HI
STORE
WAY PT
EL SEG
AZ SEG
ILS FQ
MLS FQ
40
0
40
16·2
M
10
3
0
LO
LO

Fig.4.

2174663

5/5

Fig.5.



SPECIFICATION

Aircraft instruments and controls

This invention relates to aircraft instruments and controls.

The invention is more particularly concerned with instruments for use with aircraft microwave landing systems.

Microwave landing systems (MLS) are being introduced at some airports to replace the standard Instrument Landing System (ILS) or where the ILS cannot be used. MLS employs a time-referenced scanning beam and gives a broader coverage than is possible with ILS. For this reason an aircraft equipped with an MLS receiver is able to receive landing information when it is at a greater distance away from the runway approach centre line. MLS is also less susceptible to terrain reflective interference than ILS and is therefore particularly useful at airports in mountainous areas.

Conventional dedicated MLS instruments are used to provide similar information to that available with the ILS, namely signals representing deviation from a glide path angle and offset in azimuth from a central line. This, however, fails to make full use of the MLS which could be employed, for example, in segmented approaches and for terminal area waypoint navigation. Such facilities could be available as a part of the computing facilities provided by, for example, flight management systems. Such svstems interface with a display that is used to display various aircraft functions and can be switched to display landing information derived from the MLS. These systems are expensive and only available on a small number of large aircraft. Since one of the main benefits of MLS is at mountainous airports which tend to be served by smaller aircraft, the complex flight management systems required are not usually available. Using existing aircraft computing systems to provide MLS landing information also has the disadvantage that whilst MLS information is being displayed it is difficult or confusing to display the other information which is normally provided by such systems. Also, where one instrument is used for a number of different applications this requires a large number of switches, or multi-function switches which makes operation of the instrument more difficult.

It is an object of the present invention to provide an aircraft instrument that can be used to overcome some at least of these disadvantages.

According to one aspect of the present invention there is provided an aircraft instrument for use with a microwave landing system receiver, the instrunent including a front panel with display means and setting means, wherein the setting means is settable to control display of information concerning the aircraft landing approach path and to program information concerning the aircraft landing approach path, and wherein the display means is dedicated to display of information concerning the aircraft landing approach path.

The setting means preferably includes switching means that is switchable to select between way point, elevation segment and azimuth segment, and a separate setting member for setting a value of the way point, elevation segment and azimuth segment. The setting member may be rotatable, rotation of the setting member in one direction being arranged to produce a display of azimuth deviation to one side of a centre line of a microwave landing system transmission beam, and rotation of the setting member in the other direction being arranged to produce a display of azimuth deviation to the other side of thecentre line of the microwave landing system transmission beam. The aircraft instrument may include switch means, the switch means being arranged to effect displacement of information in the display means.

The aircraft instrument may include an input for ILS receiver and distance measuring equipment and may be arranged to provide an output to autopilot equipment.

The display is preferably arranged to provide an indication of present aircraft position. The instrument may include a first display region arranged to provide information concerning the desired aircraft landing approach path and a second display region arranged to provide information concerning the aircraft landing approach path.

The instrument may be arranged to provide a digital display of at least some of said information concerning the aircraft landing approach path.

The instrument may be arranged to provide an analogue display of at least some of said information concerning the aircraft landing approach path. An analogue display may be provided of aircraft deviation in azimuth and elevation from the desired landing approach path. The resolution of the analogue display may be adjustable.

The display means may be arranged to provide a map display of an area covered by a microwave landing system transmitter and a representation of the aircraft landing approach path on said map display.

The display means may be provided by an array of electricallyenergisable elements or by a cathode-ray tube display.

An aircraft microwave landing system installation including an instrument, in accordance with the present invention, will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of the installation; and

Figures 2 to 5 show four different front panel configurations of the instrument.

With reference first to Figure 1, there is shown an aircraft microwave landing system installation comprising an MLS receiver 1 and precision distance measuring equipment (PDME) 2 which supply input signals to the MLS cockpit instrument 3. In addition to displaying landing information to the pilot, the instrument 3 may provide output signals to an autopilot 4 and an electronic flight instrumentation system (EFIS) 5. The instrument 3 includes a central processing unit (CPU) 6 coupled with a display and data set unit 7 and may be contained within either a standard 3ATI or 4ATI mounting. The system may also include an ILS receiver 8.

In operation, the MLS receiver 1 supplies signals to the CPU 6 in the instrument 3 representative of the angle of azimuth and elevation of the aircraft, the PDME 2 supplying signals representing the range of the aircraft from the runway. The CPU 6 also receives signals from the unit 7 representative of the desired course of the aircraft which may be entered in various different ways. The CPU 6 performs various standard trignometrical functions on this information to provide an indication of the present position of the aircraft or of its deviation from the desired position. This information can be presented to the pilot in a number of different ways according to the nature of the display. The instrument can also be used to process information from an ILS receiver when no MLS transmitter is available, although, in this mode, it will only be able to provide the conventional deviation signals within the narrow ILS beam.

With reference now to Figure 2 which shows the first 20 of four alternative front panels for the instrument 3. The panel 20 has a four line display region 21 made up of a matrix array of light-emitting diodes or similar electrically-energisable elements. To the left of the display region 21 there is a rotatable setting knob 22. Below the knob 22 is mounted a rotary switch 23 with six possible positions: EL SEG (elevation segment), AZ SEG (azimuth segment), WAY PT (way point), STORE, MLS FQ (MLS frequency), and ILS FQ (ILS frequency). To the right of the rotary switch 23 are two push buttons 24 and 25 for use in scrolling the display up and down respectively.

The pilot can enter the desired landing approach path in several different ways. He can define a number of way-points along the approach path in terms of their range, azimuth deviation and elevation. Alternatively, he can define a number of segments of the approach path in terms of their azimuth and elevation angles and range.

To set the way-points, for example, the pilot turns the rotary switch 23 to the position marked WAY PT which causes the legend WAY PT to appear in the top line of the display and a marker to appear in the second line. Rotating the SET knob 22 then changes the value displayed in the second line, representing range from the runway. The pilot sets this at the range of the first way-point and then presses the scroll button 25 to move the marker down to the third line of the display region 21. Rotating the SET knob 22 now causes a change in the display in the third line, which represents angular azimuth deviation. When the third line shows 0.0° this represents a way-point lying directly on the centre-line of the MLS beam, that is, aligned with the runway. Rotating the SET knob 22 in one direction causes a legend 'L' to appear at the left of the third line and the angle to increase until the desirdd azimuth deviation to the left of the centre line is reached. If the desired way-point lies to the right of the centre line, the setting knob 22 is rotated in the opposite direction causing a legend 'R' to appear at the left of the third line. When the desired azimuth deviation of the first way-point has been set, the pilot presses the scroll button 25 again to move the marker down to the bottom line of the display region 21 in which elevation angle is shown. The setting knob 22 is rotated until the desired elevation angle of the first way-point appears.

When the co-ordinates of the first way-point have been entered in this way, the pilot presses the scroll button 24 to move the displayed co-ordinates up and off the display region 21 to make room for entering the co-ordinates of the second way-point. The co-ordinates of the second way-point are entered in the same way; the range, elevation and azimuth deviation will, in general be less than that of the first way-point, as the desired course of the aircraft approaches the final glide path with a zero azimuth and 3°.

Alternatively, the pilot can set the rotary switch 23 to STORE and recall a set of stored way-points from the store in the CPU 6, by entering an appropriate code.

Instead of entering the aircraft approach path in terms of a number of way-points through which the aircraft should fly, it may be entered in terms of initial and final segments of the flight path defined by the angle and interception range of the segments. The rotary switch 23 is first set to the position marked AZ SEG and the pilot enters the track angle of the initial segment, that is, the azimuth angle of the initial segment relative to the runway axis. The pilot then enters the intercept range, that is, the distance from the runway threshold that the initial segment intercepts the 0° final segment. Additional intermediate segments could be entered, if desired, in this way.

The frequency of the MLS transmitter used at the airport is entered by turning the switch 23 to the position marked MLS FQ and setting the value displayed with the setting knob 22. Similarly, the frequency of an ILS transmitter can be preset.

The instrument described above enables the MLS approach procedure to be selected but needs an EFIS or similar system if information about the aircraft's progress through the area covered by the MLS beam is to be provided. For aircraft not equipped with an EFIS, a larger MLS instrument would be needed to provide situation information, such as that shown in Figure 3.

With reference now to Figure 3, the instrument shown has two display regions 31 and 32 located side-by-side, towards the top of a front panel 30. The instrument has a setting knob 22 and rotary switch 23 of the same form as in the instrument shown in Figure 2. The right-hand display region 32 is used to display the desired flight path information, whilst the left-hand display region 31 is used to display the actual aircraft position. For example, when in a way-point mode, the right-hand region 32 shows the range, azimuth and elevation of the next way-point from the runway whilst the left hand region 31 shows the actual range, azimuth and elevation of the aircraft at the present time. By comparing the two display regions, the pilot can estimate the aircraft deviation from the way-point and monitor the flight path so that the way-point is flown through. Similarly, in the elevation and azimuth segment mode, the right-hand region 32 shows the azimuth and elevation angle and the range in miles at which the segment intercepts the zero azimuth line. The left-hand region 31 shows the actual range from the intercept line, and the azimuth and elevation angle of the aircraft from the intercept point.

The information provided by the instrument can be displayed in whole or part in analogue form, such as shown in Figure 4. This instrument has the same setting knob 22, rotary switch 23, scrolling buttons 24 and 25 and right-hand display region 42 as the instrument shown in Figure 3, but in place of the left-hand display region, there are provided three separate display regions 46,47 and 48 which show respectiyely the azimuth angle, range and elevation of the aircraft at the present time. The azimuth display 46 is arranged horizontally whilst the elevation display 48 is arranged vertically so that they can be readily interpreted by the user. The azimuth display 46 is calibrated for 40° either side of the centre, that is, the beam width of a typical MLS system. The elevation display 48 is calibrated from zero to 10° which again covers the vertical beam width of the MLS transmitter. The range display 47 shows a digital number equal to the range of the aircraft in miles. All three display regions 46 to 48 are, in the present embodiment provided by matrix arrays of electrically-energisable elements, such as light-emitting diodes. The azimuth and elevation display regions 46 and 48 can be switched between a high resolution (HI) and a low resolution (LO) automatically or according to the user's preference, by means of a switch 49. When high resolution is required, the azimuth display presented consists of a horizontal scale line calibrated every 10° and with '0' and '40' degree legends in the centre and at opposite ends. The actual azimuth is represented by a vertical line that intersects the horizontal scale line. Similarly, the elevation display region 48 consists of a vertical scale line calibrated every two degrees and labelled at 0, 3 and 10 degrees. When low resolution is required, the calibrated, labelled line on both display regions 46 and 48 is replaced by a row of five dots as in conventional ILS indicators. The display regions 46 to 48 could be provided by electromechanical displays, if required.

In Figure 5 there is shown a front panel 50 of an alternative instrument including a cathode-ray tube screen 51. This instrument is programmed by entering the way-point or segment information as described above. The instrument is then swiched to the MAP mode by means of a switch 52 to produce a map display as shown in Figure 5. This shows a sector shape net 53 covering the area swept by the MLS transmitter. The segments of the desired approach path are represented by the four straight lines 54 to 57, the final one of which is at zero azimuth, being the standard approach path. The actual position of the aircraft is represented by a marker 58 which is shown adjacent the first segment 54 of the approach path, this segment being represented by the same colour as the marker but a different colour from the other segments. As the aircraft moves into another segment, the colour of that segment also changes to be the same as the marker. At the top left corner of the screen 51 is shown the co-ordinates of the next way-point in terms of its range and azimuth. At the top right corner of the screen 51 may be shown details of the final segment, such as its azimuth and elevation. It will be appreciated that various different co-ordinates could be shown on this screen and that they could be represented in various different ways.

Since the present instrument is dedicated to the display only of information concerning the aircraft landing approach path it can be readily provided in an aircraft without any existing flight managdment control system and at relatively low cost. Furthermore, because the instrument is dedicated to this function, the layout and labelling of the controls and switches can be selected for maximun ease of use.

The installation described above may be used to control the aircraft approach directly by means of the autopilot 4. The signals from the MLS receiver 1 are processed and scaled in such a way that suitable error and command signals can be supplied to a conventional autopilot 4 without substantial modification to the autopilot being required.

CLAIMS

1. An aircraft instrument for use with a microwave landing system receiver, the instrument including a front panel with display means and setting means, wherein the setting means is settable to control display of information concerning the aircraft landing approach path and to program information concerning the aircraft landing approach path , and wherein the display means is dedicated to display of information concerning the aircraft landing approach path.

2. An aircraft instrument according to Claim 1, wherein the setting means includes switching means that is switchable to select between way point, elevation segment and azimuth segment, and a separate setting member for setting a value of the way point, elevation segment and azimuth segment.

3. An aircraft instrument according to Claim 1 or 2, wherein the setting member is rotatable, wherein rotation of the setting member in one direction is arranged to produce a display of azimuth deviation to one side of a centre line of a microwave landing system transmission beam, and wherein rotation of the setting member in the other direction is arranged to produce a display of azimuth deviation to the other side of the centre line of the microwave landing system transmission beam.

4. An aircraft instrument according to any one of the preceding claims, including switch means, the switch means being arranged to effect displacement of information in the display means.

5. An aircraft instrument according to any one of the preceding claims including an input for ILS receiver.

6. An aircraft instrument according to any one of the preceding claims, including an input for distance measuring equipment.

7. An aircraft instrument according to any one of the preceding claims, wherein the instrument is arranged to provide an output to autopilot equipment.

8. An aircraft instrument according to any one of the preceding claims, wherein the said display means is arranged to provide an indication of present aircraft position.

9. An aircraft instrument according to Claim 8, wherein the instrument includes a first display region arranged to provide information concerning the desired aircraft landing approach path and a second display region arranged to provide information concerning the present aircraft position.

10. An aircraft instrument according to any one of the preceding claims, wherein the instrument is arranged to provide a digital display of at least some of said information concerning the aircraft landing approach path.

11. An aircraft instrument according to any one of Claims 1 to 9, wherein the instrument is arranged to provide an analogue display of at least some of said information concerning the aircraft landing approach path.

12. An aircraft instrument according to Claim 11, wherein an analogue display is provided of aircraft deviation in azimuth and elevation from the desired landing approach path.

13. An aircraft instrument according to Claim 11 or 12, wherein the resolution of the analogue display is adjustable.

14. An aircraft instrument according to any one of Claims 1 to 8, wherein the display means is arranged to provide a map display of an area covered by a microwave landing system transmitter and a representation of the aircraft landing approach path on said map display.

15. An aircraft instrument according to any one of the preceding claims, wherein the display means is provided by an array of electrically-energisable elements.

16. An aircraft instrument according to any one of Claims 1 to 14, wherein the display means is provided by a cathode-ray tube display.

17. An aircraft instrument substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

18. An aircraft instrument substantially as hereinbefore described with reference to Figures 1 and 2 as modified by Figure 3 of the accompanying drawings.

19. An aircraft instrument substantially as hereinbefore described with reference to Figures 1 and 2 as modified by Figure 4 of the accompanying drawings.

20. An aircraft instrument substantially as hereinbefore described with reference to Figures 1 and 2 as modified by Figure 5 of the accompanying drawings.

21. Any novel feature or combination of features as hereinbefore described.

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